REMARKS

Claims 48-72 are pending in the application. Now-canceled claims 1-47 are rejected. Claims 1-47 have been canceled, and claims 48-72 have been added, to more particularly point out and distinctly claim the subject matter of the present invention. The Specification has been amended to correct minor errors. Applicant hereby requests further examination and reconsideration of the application in view of the foregoing amendments and these remarks.

Attached hereto as Appendix A is a separate sheet with a clean copy of the pending claims as amended by this amendment. Attached hereto as Appendix B is a marked-up version of the changes made to the specification by the current amendment, pursuant to 37 CFR § 1.121 and MPEP § 714.

Minor changes have been made to the Specification to correct minor and inadvertent typographical and other errors, such as the incorrect reference numerals.

Applicant notes the Published Patent Application (US 2002/0090013) contains typographical errors, namely: the vector "$< 1\,\bar{1}\,0 >$" appears several times in the Specification. The overline mark over the central numeral 1 is difficult to discern in the published application, namely in paragraphs [0032] and [0033]. Additionally, the word "stop" is erroneously capitalized to read as "Stop" in the last word of paragraph [0036]. Applicant requests that any action be taken by the PTO to ensure that such errors are not repeated in any issued patent.

On page 2 of the Office Action, the Examiner objected to the drawings for failing to show the driver circuit of claim 20. As the pending claims have been canceled, this objection is moot. Further, said feature is not present in new claims 48-72.

On pages 2-3 of the Office Action, the Examiner rejected claims 11 and 27 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. As the pending claims have been canceled, this objection is moot. Further, Applicant submits that the new claims 48-72 are not indefinite and that the Examiner's rejection is ungrounded and inapplicable. The Examiner stated, regarding now-canceled dependent claims 11, 27, and 40, that it is unclear as to how Applicant mounts the edge-receiving optical devices to the bench substrate as recited in claim 1 (or 22 or 35),

if the devices have not been fabricated as implied by claim 11 (or 27 or 40). Applicant is unclear whether the Examiner meant to reject the dependent claims 11, 27, and 40 (because the Examiner implies these claims are clear as to how the devices are mounted), or the independent or other claims. Applicant notes that the Specification provides:

> In one embodiment, the array 40 of the edge-receiving optical devices is *fabricated independently* from the optical bench substrate 20, in which case the array 40 of the edge-receiving optical devices is *mounted inside the slot* 70 on the optical bench substrate 20. As will be appreciated, various mounting techniques may be employed to mount the array 40 of the edge-receiving optical devices on the slot 70. For example, the array 40 of the edge-receiving optical devices may be mounted by solder or epoxy (not shown). In an alternative embodiment, the array 40 of the edge-receiving optical devices is *monolithically fabricated on the optical bench substrate* 20 in the position generally indicated by slot 70 and array 40 of Fig. 1 (in which case there is no actual slot 70). [Specification, page 9 line 25 to page 10 line 3 (para. 046 of Applicant's published application), emphasis added; see also page 6, lines 15-17 (para. 034 of Applicant's published application).]

In other words, array 40 of edge-receiving optical devices can be monolithically fabricated on the bench substrate itself, as claimed in now-canceled dependent claims 11, 27, and 40. Alternatively, if array 40 is not monolithically fabricated on the bench substrate, then it is mounted on it using the alignment features provided (e.g. slot 70), e.g. by using solder or epoxy. Since array 40 can be mounted on the substrate, relative to laser array 30, by either fabricating it independently and then mounting it to the substrate, or by monolithically fabricating it as part of the substrate itself, it is a permissible claim technique to specify one of these features in a dependent claim. Further, Applicant submits that a claim such as now-canceled independent claim 1 is clear in specifying "mounting the one or more edge-receiving optical devices to the optical bench substrate. The mounting may be done in a number of ways, including by mounting it to the substrate after fabricating it independently, or by monolithically fabricating it as part of the substrate itself, as clearly described in the Specification. For these reasons, Applicant submits that any current claims, such as the new independent claims, which specify that the edge-receiving optical devices are mounted on the optical bench substrate, are not indefinite.

On page 3 of the Office Action, the Examiner rejected claim 42 under 35 U.S.C. § 101 because the claimed recitation of a use, without setting forth any steps involved in the process, results in an improper definition of a process. As the pending claims have been canceled, this objection is moot. No current pending claim is drafted in this manner.

On pages 3-4 of the Office Action, the Examiner rejected claims 1, 4, 7, 8, 10, 12, 18, 19, 20-26, and 32-42 under 35 U.S.C. § 102(e) as being anticipated by Wu *et al.* On pages 5-6 of the Office Action, the Examiner rejected claims 2, 3, 5, 6, and 9 under 35 U.S.C. § 103 as being unpatentable over Wu *et al.* in view of Evans *et al* and Melman. On pages 6-7 of the Office Action, the Examiner rejected claims 13-17, 28-31 and 43-47 under 35 U.S.C. § 103(a) as being unpatentable over Wu *et al.* in view of Ota *et al.* and McCaul *et al.*

As the pending claims have been canceled, the § 102(e) and § 103(a) rejections based on the cited prior art are moot. Applicant further submits that, for the following reasons, the new claims 48-72 are neither anticipated by or obvious in view of the cited references.

New independent method claim 48 and apparatus claim 62 are reproduced below for convenience:

> 48. A method for aligning and mounting at least one surface-emitting laser with respect to at least one edge-receiving optical device, the method comprising the steps of:
>
> (a) providing an optical bench substrate having a mounting surface in the x-y coordinate plane, the mounting surface having a plurality of alignment features defined therein, the optical bench substrate having at least one edge-receiving optical device mounted on the mounting surface, wherein:
>
> each of the at least one edge-receiving optical device has an input edge in the x-z coordinate plane, each said input edge being perpendicular to both the mounting surface and to the substrate of the at least one edge-receiving optical device, whereby each of the at least one edge-receiving optical device is adapted to receive light traveling in the y direction into its input edge;
>
> each of the at least one edge-receiving optical device is for conditioning light traveling in the y-direction and received at its input edge;
>
> the at least one surface-emitting laser comprises a primary epi surface from which laser radiation is emitted and a mounting edge perpendicular to the primary epi surface; and
>
> the plurality of alignment features are for receiving the mounting edge of the at least one surface-emitting laser and for securing the at least one surface-emitting laser from movement in the x direction and in the y direction; and

(b) mounting the at least one surface-emitting laser, at its mounting edge, on the mounting surface and within said plurality of alignment features so that the at least one surface-emitting laser is secured from movement in the x direction and in the y direction, wherein the plurality of alignment features are positioned on said mounting surface with respect to the at least one edge-receiving optical device so that: the primary epi surface of the at least one surface-emitting laser is in the x-z coordinate plane and the at least one surface-emitting laser, when activated, will emit laser radiation in the y direction and into the input edge of the at least one edge-receiving optical device, respectively, whereby the at least-one surface-emitting laser is directly optically coupled to the at least one edge-receiving optical device, respectively.

62. An apparatus comprising:
(a) an optical bench substrate having a mounting surface in the x-y coordinate plane;
(b) at least one edge-receiving optical device mounted on the mounting surface, wherein:
each of the at least one edge-receiving optical device has an input edge in the x-z coordinate plane, each said input edge being perpendicular to both the mounting surface and to the substrate of the at least one edge-receiving optical device, whereby each of the at least one edge-receiving optical device is adapted to receive light traveling in the y direction into its input edge; and
each of the at least one edge-receiving optical device is for conditioning light traveling in the y-direction and received at its input edge; and
(c) at least one surface-emitting laser having a primary epi surface from which laser radiation is emitted and a mounting edge perpendicular to the primary epi surface, the at least one surface-emitting laser being mounted at its mounting edge on the mounting surface, and positioned with respect to the at least one edge-receiving optical device, so that the primary epi surface of the at least one surface-emitting laser is in the x-z coordinate plane and the at least one surface-emitting laser, when activated, will emit laser radiation in the y direction and into the input edge of the at least one edge-receiving optical device, respectively, whereby the at least-one surface-emitting laser is directly optically coupled to the at least one edge-receiving optical device, respectively.

In both independent claims, at least one edge-receiving optical device is mounted on the x-y plane mounting surface of an optical bench substrate, so that the input edge of the at least one edge-receiving optical device is in the x-z coordinate plane, i.e. perpendicular to the mounting surface. Thus, the edge-receiving optical device receives light traveling in the y direction (parallel to the mounting surface) into its input edge. The edge-receiving optical device is for conditioning light that it receives at this input edge (e.g., by modulating and/or amplifying it, as specified in various

dependent claims). A corresponding at least one surface-emitting laser is mounted on its edge on the mounting surface, so that the primary epi surface from which laser radiation is emitted is vertical, i.e. in the x-z coordinate plane and positioned so that when it is operated, it emits laser radiation in the y direction, directly into the input edge of the at least one edge-receiving optical device. In this manner, a *surface-emitting* laser (or array) can be *directly optically coupled* to an *edge-receiving* optical device (or array).

As explained in the Specification, the claimed invention permits several advantages to be obtained. For example, the invention "permits coupling a high percentage of power from a surface emitting laser to an external modulator or other device" and allows "data modulation rates higher than direct modulation limits. [] Another advantage is aligning arrays of surface emitting lasers with arrays of modulators and, in particular, aligning an array of surface-emitting lasers with a corresponding array of edge-receiving optical devices" (page 4, lines 7-13). Thus, by mounting the surface-emitting laser on its edge, so that its emitting face is "vertical" with respect to the mounting surface of the optical bench, it can be coupled directly into the input edge of the edge-receiving optical device, which is mounted on the bench parallel to the mounting surface. This allows higher coupling efficiency than if the surface-emitting laser were to be indirectly coupled, via an intermediate reflectiot, to the edge-receiving device, as would have to be done were the surface-emitting lasers mounted parallel to the mounting surface, as is conventionally done. Further, by using the alignment features (method claim 48), the surface-emitting laser may be *passively* aligned with the edge-receiving optical device.

The cited references, either alone or in combination, simply do not teach or even suggest these claimed features nor would they result in the advantages provided by the claimed invention. Wu *et al.* is different in that the surface emitting lasers are mounted parallel to the mounting surface and emit light downward, toward a mirror, where it is then reflected into a fiber. Wu *et al.*, Paragraph [0033]; Figs. 2, 4. Thus, it is not directly coupled and has a lower coupling efficiency. Wu *et al.* also does not teach mounting the surface-emitting laser on its edge. The surface-emitting lasers of Wu et al. are also coupled into a fiber, not an edge-receiving optical device that conditions

the signal. Further, Wu *et al.* would require active alignment because the surface-emitting laser is merely fixed by solders 14 (paragraph [0031]), with no alignment features provided to secure the movement of the lasers in the x-y directions so as to permit passive alignment.

The other cited references also do not teach the claimed features of Applicant's invention. Even if combined the cited references do not teach Applicant's claimed invention; e.g., none of them even suggest mounting surface-emitting lasers on their edge on a mounting substrate, nor doing so in order to directly couple the output into an edge-receiving optical device also mounted (in parallel) on the mounting substrate. Melman, for example, does not show mounting a surface-emitting laser on its edge, nor directly coupling a laser to a device. Instead, Melman appears to employ an edge-emitting laser, not a surface-emitting laser; and the light from Melman is coupled after a reflection into a fiber (not into a device that can condition the signal). Evans et al. also does not teach mounting surface-emitting lasers on their edge on a mounting substrate, nor directly coupling their output into an edge-receiving optical device. Instead, Evans *et al.*'s VCSELs are mounted conventionally, not on their edge, and are coupled to a waveguide fabricated in the same epi plane as the emission surface, not directly optically coupled (or coupled at all) into an edge-receiving optical device.

The Assistant Commissioner for Patents is hereby authorized to charge any additional fees or credit any excess payment which may be associated with this communication to our deposit account **50-1705**.

In view of the foregoing remarks and amendments, new claims 48-72 are believed to be in condition for allowance. Allowance of the pending claims at an early date is earnestly solicited.

The undersigned may be contacted for any questions.

Respectfully submitted,

Date: January 27, 2003

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ATTACHMENT A

CLEAN COPY OF PENDING CLAIMS (AS OF DATE OF RESPONSE)

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48. A method for aligning and mounting at least one surface-emitting laser with respect to at least one edge-receiving optical device, the method comprising the steps of:

(a) providing an optical bench substrate having a mounting surface in the x-y coordinate plane, the mounting surface having a plurality of alignment features defined therein, the optical bench substrate having at least one edge-receiving optical device mounted on the mounting surface, wherein:

each of the at least one edge-receiving optical device has an input edge in the x-z coordinate plane, each said input edge being perpendicular to both the mounting surface and to the substrate of the at least one edge-receiving optical device, whereby each of the at least one edge-receiving optical device is adapted to receive light traveling in the y direction into its input edge;

A3

each of the at least one edge-receiving optical device is for conditioning light traveling in the y-direction and received at its input edge;

the at least one surface-emitting laser comprises a primary epi surface from which laser radiation is emitted and a mounting edge perpendicular to the primary epi surface; and

the plurality of alignment features are for receiving the mounting edge of the at least one surface-emitting laser and for securing the at least one surface-emitting laser from movement in the x direction and in the y direction; and

(b) mounting the at least one surface-emitting laser, at its mounting edge, on the mounting surface and within said plurality of alignment features so that the at least one surface-emitting laser is secured from movement in the x direction and in the y direction, wherein the plurality of alignment features are positioned on said mounting surface with respect to the at least one edge-receiving optical device so that: the primary epi surface of the at least one surface-emitting laser is in the x-z coordinate plane and the at least one surface-emitting laser, when activated, will emit laser

radiation in the y direction and into the input edge of the at least one edge-receiving optical device, respectively, whereby the at least-one surface-emitting laser is directly optically coupled to the at least one edge-receiving optical device, respectively.

A3 cont'd

49. The method of claim 48, wherein the plurality of alignment features comprise a pair of x-direction stops for securing from movement in the x direction and a pair of y direction stops, the pair of x direction stops bounding the mounting edge and for securing the at least one surface-emitting laser from movement in the x direction and the pair of y direction stops bounding the mounting edge and for securing the at least one surface-emitting laser from movement in the y direction.

50. The method of claim 48, wherein the at least one surface-emitting laser comprises an array of surface-emitting lasers and the at least one edge-receiving optical device comprises a corresponding array of edge-receiving optical devices having one edge-receiving optical device for each respective surface-emitting laser.

51. The method of claim 48, wherein step (b) comprises the step of mounting the at least one surface-emitting laser, at its mounting edge, on the mounting surface by use of solder or epoxy.

52. The method of claim 48, wherein step (a) comprises the step of photolithographically fabricating the plurality of alignment features in the mounting surface.

53. The method of claim 48, wherein step (a) comprises the step of fabricating the plurality of alignment features in the mounting surface using electron beam lithography.

54. The method of claim 48, wherein the edge-receiving optical devices of the at least one edge-receiving optical device are edge-receiving optical modulators.

55. The method of claim 54, wherein each of the at least one edge-receiving optical device

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further comprises an edge-receiving optical amplifier positioned in the path of the output signal from said each edge-receiving optical modulator.

56. The method of claim 48, wherein the edge-receiving optical devices of the at least one edge-receiving optical device are edge-receiving optical amplifiers.

A3 cont'd

57. The method of claim 48, wherein the edge-receiving optical devices of the at least one edge-receiving optical device are semiconductor optical amplifiers (SOAs).

58. The method of claim 48, wherein each of the at least one surface-emitting laser is a vertical-cavity surface-emitting laser (VCSEL).

59. The method of claim 48, wherein the optical bench substrate is a silicon optical bench.

60. The method of claim 48, wherein step (a) comprises the step of monolithically fabricating the at least one edge-receiving optical device on the mounting surface of the optical bench substrate.

61. The method of claim 48, wherein step (a) comprises the steps of:

photolithographically fabricating the plurality of alignment features in the mounting surface;

photolithographically fabricating a second plurality of alignment features in the mounting surface;

fabricating the at least one edge-receiving optical device independently of the optical bench substrate; and

mounting the at least one edge-receiving optical device on the mounting surface of the optical bench substrate, in the second plurality of alignment features.

62. An apparatus comprising:

(a) an optical bench substrate having a mounting surface in the x-y coordinate plane;

A3 cont'd

(b) at least one edge-receiving optical device mounted on the mounting surface, wherein:

each of the at least one edge-receiving optical device has an input edge in the x-z coordinate plane, each said input edge being perpendicular to both the mounting surface and to the substrate of the at least one edge-receiving optical device, whereby each of the at least one edge-receiving optical device is adapted to receive light traveling in the y direction into its input edge; and

each of the at least one edge-receiving optical device is for conditioning light traveling in the y-direction and received at its input edge; and

(c) at least one surface-emitting laser having a primary epi surface from which laser radiation is emitted and a mounting edge perpendicular to the primary epi surface, the at least one surface-emitting laser being mounted at its mounting edge on the mounting surface, and positioned with respect to the at least one edge-receiving optical device, so that the primary epi surface of the at least one surface-emitting laser is in the x-z coordinate plane and the at least one surface-emitting laser, when activated, will emit laser radiation in the y direction and into the input edge of the at least one edge-receiving optical device, respectively, whereby the at least-one surface-emitting laser is directly optically coupled to the at least one edge-receiving optical device, respectively.

Y 63. The apparatus of claim 62, wherein the at least one edge-receiving optical device is monolithically fabricated on the optical bench substrate.

64. The apparatus of claim 62, wherein the mounting surface has a plurality of alignment features defined therein and the at least one surface-emitting laser is mounted at its mounting edge in the plurality of alignment features.

65. The apparatus of claim 62, wherein the at least one surface-emitting laser comprises an array of surface-emitting lasers and the at least one edge-receiving optical device comprises a corresponding array of edge-receiving optical devices having one edge-receiving optical device for

each respective surface-emitting laser.

66. The apparatus of claim 62, wherein the edge-receiving optical devices of the at least one edge-receiving optical device are edge-receiving optical modulators.

A3 Cont'd

67. The apparatus of claim 66, wherein each of the at least one edge-receiving optical device further comprises an edge-receiving optical amplifier positioned in the path of the output signal from said each edge-receiving optical modulator.

68. The apparatus of claim 62, wherein the edge-receiving optical devices of the at least one edge-receiving optical device are edge-receiving optical amplifiers.

69. The apparatus of claim 62, wherein the edge-receiving optical devices of the at least one edge-receiving optical device are semiconductor optical amplifiers (SOAs).

70. The apparatus of claim 62, wherein each of the at least one surface-emitting laser is a VCSEL.

71. The apparatus of claim 62, wherein the optical bench substrate is a silicon optical bench.

72. The apparatus of claim 62, wherein the at least one edge-receiving optical device has been monolithically fabricated on the mounting surface of the optical bench substrate.

ATTACHMENT B

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

The Paragraph spanning lines 1-14 of page 6 has been amended as follows:

–The present invention, however, is not limited to the above-described embodiment. In fact, in other embodiments, surface-emitting devices may emit light parallel to the <110> vector or the vector. In another embodiment, an array of edge-receiving optical devices is used to receive and condition the output signals (laser output beams) of an array of SELs. Referring now to Fig. 1, there is shown an isometric view of a laser system 10 for conditioning the output signals of a one-dimensional array of vertical-cavity surface-emitting lasers (VCSELs) in accordance with an embodiment of the present invention. The system 10 includes an optical bench substrate 20. The system 10 further includes an array 30 of VCSELs, which is mounted on the optical bench substrate 20, and an array 40 of edge-receiving optical devices, which is also positioned on the optical bench substrate 20. The VCSELs of array 30 have the primary epi surface in the x-z coordinate plane and thus emit parallel to the y axis. The corresponding edge-receiving optical devices of array 40 receive light from VCSELs of array 30 in the edge in the x-z coordinate plane, which edge is perpendicular to the epi surface of the array [30] 40, which is parallel to the x-y coordinate plane.--

The Paragraph spanning lines 1-5 of page 7 has been amended as follows:

--In an embodiment, to precisely align the VCSELs of array [10] 30 with corresponding optical devices, for effective optical coupling, array [10] 30 is mounted on substrate 50, which forms a silicon (or other material) optical bench, using various alignment features, such as stops 50 and grooves 60 and 70 (which grooves are defined by bounding walls, which may also be viewed as stops).--